RS-488

Highway Impacts on Incomes and Employment in the Ozarks

A STUDY OF STATISTICAL RELATIONSHIPS

U.S. Department of Agriculture
Economic Research Service
In Cooperation with the Missouri
Agricultural Experiment Station
University of Missouri

ABSTRACT

Highway impacts on Ozarks incomes and employment during the 1950's are empirically analyzed by means of rank correlation and stepwise regression. Results indicate that highways were not among the most critical factors in the Ozarks Region's development. If new highways are built, two-lane, paved, State-numbered roads connecting existing Federal routes and also local paved county roads connecting rural areas with urban centers would be more beneficial for economic development than other highway types. Highways with dissimilar qualities are classified into five distinct types, with the number of lanes, type of surface, and network integration used as criteria. Relevant regional economic growth theories are also reviewed.

Key Words: Highway impacts, Ozarks Region, regional development, incomes, employment, rank correlation, stepwise regression, highway quality.

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PREFACE

Some recent regional economic development plans have emphasized public investments in physical overhead capital, especially new highways, to help eradicate regional poverty. This study, based on data for total highway mileage in 1954, 1959, and 1963 in the Ozarks Region, provides a benchmark analysis of the role of highways in the development of a specific region. It is hoped that it will facilitate rapid further evaluation of the impact of highways on the development of various regions when 1970 or other more current data become available.

Knowledge of events that have occurred in the Ozarks Region indicates that analysis based on more recent data will not provide conclusions that vary significantly from those presented. This report should aid public agencies and citizen advisory groups in making decisions regarding plans for economic development.

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We are particularly indebted to the Arkansas State Highway Department, Missouri State Highway Department, Oklahoma Department of Highways, and Oklahoma Turnpike Authority for furnishing highway data and reports. The faculties of the Departments of Agricultural Economics and Statistics at the University of Missouri provided valuable guidance and assistance. Appreciation is also extended to the Area Analysis Branch, EDD, and to James P. Miller, Lloyd D. Bender, and Melvin R. Janssen (all in EDD) for valuable assistance in conceptualization and planning of the study and coordination with the larger project.

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The priority given to highway construction as a means of promoting regional development may need to be questioned, based on this analysis of highway impacts in a major depressed region of the United States. During 1954-63, highways were not among the most critical factors in the development of the area since designated the Ozarks Economic Development Region. If the region uses highways as a development technique, emphasis should be placed first on State roads integrated with existing Federal routes, and second, on local paved roads connecting rural hinterlands with urban centers.

Analysis of highway relationships with incomes and employment in the Ozarks Region indicates that the overall access network -- comprised of multilane, U.S.-numbered, and State-numbered highways -- was more correlated with incomes and employment than were any of the network's specific components. State-numbered highways were the most important component of the access network. These highways could thus substitute for multilane or U.S.-numbered highways.

Highways, especially local paved roads and the overall access network, were moderately correlated with incomes. Highways, in general, were more closely related to total incomes than to per capita or family median incomes. They were only slightly related to employment rates and intercounty job commuting. Local roads were moderately associated with full-time employment.

Highways, especially local paved roads and the access network, were moderately associated with total manufacturing employment and total tertiary employment in trades and services. Much variability was evident among specific manufacturing sectors but very little among specific tertiary sectors.

Multilane highways usually followed high incomes and employment. Local roads generally preceded employment. Whether employment and income changes associated with other road types preceded or followed the roads was indeterminable.

Stepwise regression procedures indicated that the net contributions of road types were probably less than those indicated by rank correlations. Education levels of the adult population and urbanization were other important factors in the regression models.

HIGHWAY IMPACTS ON INCOMES AND EMPLOYMENT IN THE OZARKS...

A STUDY OF STATISTICAL RELATIONSHIPS

By

John A. Kuehn 1/ and Jerry G. West 2/

INTRODUCTION AND RESEARCH METHODS

Several State and regional plans for development of areas characterized by extensive and chronic poverty emphasize public investment in highway construction to foster development and to improve the regional share of national economic growth.

Location theory postulates that more and better highways in an area should help attract manufacturing and tertiary service firms by lowering transport cost, including time. The formation of an industrial export base, however, depends on the totality of a region's comparative advantages. Neoclassical growth models hypothesize that highways should facilitate economic growth by increasing potential regional production, factor mobility, and commodity movements. These theories indicate that highways function only as permissive causes of regional development insofar as they primarily affect potential regional supply of factors of production.

Drawing on these theories, various economists and planners have questioned the high priority that some State and regional development programs have assigned to highway development. In response to this situation, the primary objective of this research was to investigate highway impacts on a depressed region's incomes and employment. Specific objectives were to:

(1) Specify a meaningful classification of highways for measurement purposes.

(2) Inventory the highway resource of the Ozarks Region from 1954 through 1963.

(3) Study empirically highway relationships with Ozarks incomes (1959) and employment (1960) by suitable statistical techniques to determine:

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(a) If highways were related to incomes and employment,

(b) If highway types preceded or followed incomes and employment,

(c) Highway types most beneficial for regional development,

(d) Industry types most related to highways.

(4) Refine regional economic theory concerning highways.

(5) Indicate policy implications.

Ozarks Region

The selected study area was the Ozarks Region, later officially delineated (on Mar. 1, 1966) the Ozarks Economic Development Region under provisions of the 1965 Public Works and Economic Development Act. This included 44 counties in Arkansas, 44 in Missouri, and 37 in Oklahoma. During 1954-63, employment opportunities within the region did not keep pace with national growth, resulting in outmigration of the young, unemployment, underemployment, and low incomes. Per capita income in 1959 was lower for the Ozarks than for the Nation as a whole or for Appalachia. The depressed Ozarks economy was characterized by its dependence on agricultural employment with some highly localized activities related to mining, recreation, forest products, and slow-growth manufacturing (22). 3/

The Ozarks Region will be fairly well served east and west by the interstate highway system when it is completed. No north-south interstate routes will pass through the region. Several U.S.-numbered highways serve as important north-south routes. Mountainous areas of the Ozarks have few highways. Numerous changes have occurred among highway types and within counties, even though total road mileage has not changed much. Multilane mileage during 1954-63 increased substantially -- usually at the expense of Federal-type mileage. Historically, the interstate system has been constructed paralleling Federal routes which have either been phased out or redesignated as State routes. Some gravel U.S.-numbered routes in Arkansas and Oklahoma were upgraded to paved Federal roads between 1954 and 1963. Some unpaved roads were also improved to State and local types. Therefore, the Ozarks Region's road system was affected not only by overall total expansion but also by internal improvement; both quantitative and qualitative aspects were important. One major redesignation occurred after 1960, when Arkansas State 11 north of U.S. 67 became U.S. 167.

A fairly succinct definition of regional economic development follows, based on legislative guidelines: Development clearly implies sustainable employment increases resulting in favorable and equitable income changes relative to the Nation (24, pp. 435-440; 39). Total income received by regional residents indicates the volume of economic activities and the state of regional

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3/ Underscored numbers in parentheses refer to works listed in References, at the end of this report.

development. Per capita and family median incomes of area residents connote individuals' and families' welfare or development status. This study uses data by county on total, per capita, and family median incomes in 1959. 4/

Employment data provide a detailed and uniform measure of distinct economic activities. Also, the total number of employees by various standard industrial classifications furnishes a rough but readily available indicator of industrial location. Thus, employment data for 1960 are presented by county for various civilian labor force characteristics and for sector employment. 5/

Measurement of Highway Inputs

Dissimilarities among highway types hamper empirical investigation of highway impacts. Highways as a whole are not homogeneous factors or inputs. For example, a mile of gravel feeder road is not comparable to a mile of national interstate highway. Quality and quantity are both important. Ideally, a measurement of highway quality should indicate the effectiveness of facilities for serving traffic. Such a measure involves many roadway and traffic conditions. Roadway conditions include number and arrangement of lanes, width of lanes, shoulders, lateral clearances, surface types, vertical and horizontal alignment, access control, and network integration. Traffic conditions involve spacing and headway, volumes, vehicle types, speeds, and accident rates (5, 41).

Four methods for classifying highways were reviewed. These were road-user costs (8, 41), capacity ratings (5, 19), sufficiency ratings (7, 31), and administrative criteria (2, 4, 18). Since historical measurements of practical capacity and road-user costs were not available and because sufficiency ratings were not comparable among States, the following criteria were used to measure highway mileage qualitatively:

1. Number of lanes,

2. Paved or nonpaved surfaces,

3. Integration with traffic routes.

Data for highway mileage according to these three criteria were obtained from highway maps, traffic volumes maps, and reports and correspondence of the Arkansas, Missouri, and Oklahoma State Highway Departments and the Oklahoma Turnpike Authority. With these data we approximately measured the status of highway systems at the end of 1954, 1959, and 1963.

The inventory included all county- and State-administered highways and roads plus all turnpikes for the Ozarks Region (tables 1, 2, 3). This encompassed nearly all rural roads and excluded most urban local roads administered by city governments. Highways with dissimilar qualities were classified into five distinct types and three composite networks based on the criteria given above (number of lanes, type of surface, and network integration). The five

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4/ Sources of these data were (17 and 36).
5/ Sources: (1, 36, 37, 38).

road types are:

1. Multilane -- All turnpikes, U.S.-numbered, and State-numbered roads of four or more paved lanes.

2. Federal -- All U.S.-numbered roads of two or three paved lanes.

3. State -- All State-numbered roads of two or three paved lanes.

4. Local -- All county-administered and State-lettered roads of any number of paved lanes.

5. Unpaved -- All county-administered and State-administered roads of any number of unpaved lanes.

The three composite networks are:

1. Access -- Sum of multilane, Federal, and State highways.

2. Feeder -- Sum of local and unpaved roads.

3. Total -- Sum of access and feeder roads.

The inventory was compiled on a county basis because the county is the smallest spatial unit for which consistent highway, income, and employment data were readily available. Highway mileage so classified was divided by 100 square miles of 1960 land area in each respective county (36).

A rank correlation matrix was calculated for highways, by types, by years. Inspection of this matrix indicated high associations over time for the same road types but low associations among the five distinct types for the same year. The access composite was more associated with State highways than with multilane or Federal highways. Federal and State highways were inversely related. Thus, an undefined amount of substitutability existed among multilane, Federal, and State highways, with the access composite being most related to State highways.

Statistical Techniques

The basic method for estimating Ozarks highway impacts entailed use of historical cross-sectional data for the entire Ozarks Region of 125 counties. Three time-dated models were used in which 1954, 1959, and 1963 highway types were each related to 1959 incomes or 1960 employment. It was assumed that 4- to 5-year lags were realistic. If a specific highway type was more associated in 1963 than in 1954 or 1959 with income or employment, it could be said that this type temporally followed income or employment. Similar statements can be made for other temporal associations. Such time sequences possess causative implications in a nonanticipatory framework. Income and employment data were measured in absolute total amounts descriptive of the total state of regional development. The primary statistical technique used was Spearman's rank correlation; the secondary technique was stepwise regression using a 5-percent test of the increment in explained variation (9, pp. 86-95, 171-72; 33, pp. 202-213).

Total Income

Highways were moderately correlated with total income for each of the 3 years 1954, 1959, and 1963 (table 4). The three networks were moderately associated with total income, but time sequence was judged indeterminable. The access network was the most related network type; and it was more associated with total income than were any of its components -- multilane, Federal, or State highways -- thereby indicating substitutability among these three. In time sequence, multilane highways followed total income. But this was probably a result of the construction history of the interstate system. Interstate highways, mainly replacing Federal routes, have historically been built first in heavily populated areas. Among the five distinct road types in 1954, local roads were most related to total income. Federal highways were also important.

Most of the variation in 1959 total income was explained by the stepwise regression equations (table 5). Examination of residuals indicated little, if any, violation of statistical assumptions. Urbanization, education, and various interaction terms were important. The net effect -- for example, of local roads -- depended on interaction with other factors.

It was concluded that the access network -- primarily Federal and State highways -- and local roads were the road types most explanatory of total income variations. But even then the explained gross variation, as indicated by rank correlation results, did not exceed 47 percent for any specific road type. Net explanation was probably less as revealed by regression models wherein interaction terms, education, and urbanization were prominent.

Per Capita Income

Among the three composite road types, only the access network was even moderately correlated with per capita income (table 4). The access network was more associated with per capita income than were any of its components, except in 1963. Again, there appeared to exist substitutability among multilane, Federal, and State highways. Time sequence was judged indeterminable except for multilane highways, which temporally followed per capita income. This probably reflected the high substitution noted above and multilane construction history. Among the five distinct types in 1954, local roads and then State highways were most related to per capita income.

Stepwise regression models indicated that nonhighway factors were important -- especially urbanization, education, and tertiary employment in trades and services (table 6). Examination of residuals indicated some violation of statistical assumptions. Regression equations slightly overestimated low income levels and underestimated high income levels. State highways were important in interaction with tertiary employment. Local roads were not important in the regression models.

Therefore, State highways, via the access network, and local roads were the road types most explanatory of per capita income variations. Gross explanation of income variation did not exceed 44 percent by State highways nor 30

percent by local roads. Net explanation was most likely less as noted in stepwise regression models.

Family Median Income

Of the composite road types, only the access network was even moderately correlated with family median income (table 4). Again, substitutability existed among multilane, Federal, and State highways. The overall access network was more influential than any specific type highway, except in 1963. Time sequence was judged indeterminable except for multilane highways as noted above. Among the five distinct road types in 1954, local roads were most associated with family median income. Federal and State highways were only slightly to moderately related to income. State highways, however, were the major component of the access network.

Stepwise regression models revealed that education, urbanization, and manufacturing employment were important factors associated with family median income (table 7). State highways were prominent in the 1954 model. Local roads entered the models in interaction with other factors and highway types. Examination of residuals revealed that regression equations slightly underestimated high income levels.

Consequently, State and local roads were the road types most explanatory of variations in family median income. Gross explanation did not exceed 35 percent for either type alone. The net effects of State and local roads could be less as indicated by the complex interaction terms in the regression models.

Income Distribution

Both rank correlation coefficients and stepwise regression equations indicated that highways were usually more associated with total aggregate income than with per capita or family median incomes. The latter two incomes are measures of the central tendencies of income distributions within counties. Highway networks were more related to total incomes than to average incomes and their distributions. Specific road types were usually more correlated with total income than with average income measurements; State and local roads were exceptions. It was inferred that highways were generally more associated with the total volume of economic activity than with its distribution. Population size and income distribution characteristics might partially explain these findings.

HIGHWAY IMPACTS ON OZARKS EMPLOYMENT

Civilian Labor Force Characteristics

Theoretically, counties with good highways should possess high employment rates and full-time employment because of resultant economic activity. They would have a low percentage of the civilian labor force working outside the county of residence. If more and better highways attract industry and stimulate employment opportunities within counties, highways should be inversely related to intercounty commuting.

However, analysis showed that highway relationships with these civilian labor force characteristics were generally insignificant. Analyses indicated little or no association of highways with employment rates or commuting (table 8). Only local roads were even moderately correlated with full-time employment; and local roads temporally followed full-time employment. Local and unpaved roads entered the stepwise regression models also (table 9, 10, 11). However, these models were highly suspect. Examination of residuals indicated definite violation of statistical assumptions. In sum, highways exhibited little or no relation with these three civilian labor force characteristics.

Manufacturing Employment

Attraction of manufacturing plants was a major highway impact hypothesized in previous studies. The present study found that for total manufacturing employment and location, local roads and the access network were the most influential road types, being moderately correlated with manufacturing employment (table 12). Federal highways were the most important access-type road in 1954; but the overall access network was more closely associated with manufacturing than were Federal highways. Thus State highways, connecting with existing Federal routes, would probably serve as good substitutes for additional Federal routes. Time sequence was generally indeterminable except that multilane highways followed and local roads preceded manufacturing employment. Local roads were also the distinct type most related to total manufacturing employment.

Stepwise regression models verified these analytical results (table 13). Examination of residuals indicated little, if any, breach of statistical assumptions. Urbanization with its concomitant services was an important variable for explaining total manufacturing employment. Local roads and Federal highways were the more important road types in the 1954 model; they often interacted with urbanization and other highway types. The overall road network, especially access, was probably more important than specific multilane, Federal, and State highways.

Local roads alone accounted for about 25 percent of the gross variation in employment; access networks explained about 16 percent of the gross variation. Net explanations of variations in total manufacturing employment by Federal and local roads were most likely less than gross explanations as indicated by the importance of interaction terms and urbanization in the regression equations.

Highway relationships with employment in eight different manufacturing sectors were also analyzed in gross terms by means of rank correlation (table 12). In those cases where highways were related at all, time sequence was commonly determinable only for multilane highways and local roads. The former followed employment; the latter preceded it. Highways were not an important factor in plant locations for the textile and wood products sectors. For the location of food processing plants, the feeder road network -- both local and unpaved roads -- was moderately important. For the location of chemical, transportation equipment, and metal manufacturing plants, interregional access roads -- mainly Federal highways in 1954 -- and local roads were moderately influential. For printing and machinery manufacturing, interregional access -- provided by Federal highways -- and local roads were moderately to highly important factors. Federal highways offered access to interregional markets.

It should be noted, however, that access networks were more important than specific types of roads. Local roads provided admittance to the access network and also contact with expanded laborsheds. Consequently, it was concluded that local roads plus State highways well integrated with existing Federal routes were the road types most attractive for manufacturing location.

Trades and Services Employment

Previous studies have hypothesized that more and better highways extend marketing areas for concentrated trades and services employment. It has also been suggested that highways enhance accessibility to recreation areas with consequent growth of business catering to tourism (a major industry in the Ozarks Region.)

A related theory is that if highways facilitate industrial inmigration and income expansion, trades and services would be attracted. More and better highways in a county would theoretically encourage location and enlargement of tertiary firms therein.

The present study found highway networks to be moderately to highly correlated with total trades and services employment (table 14). The access network was more associated with total tertiary employment than were multilane, Federal, or State highways. Substitutability was evident among these three road types. Federal highways were more important than State highways. Multilane highways followed employment. Local roads were highly correlated with and preceded tertiary employment. Time sequence was generally indeterminable for other road and network types.

Stepwise regression results confirmed these findings (table 15). Federal highways and local roads were important factors, often in interaction with urbanization, education, and other road types. Examination of residuals indicated only slight infringement upon statistical assumptions.

Gross explanation of variations in tertiary employment did not exceed 45 percent for either access or local roads. Net explanation could be less on account of other factors and interaction terms in the regression models.

In general, total tertiary employment along with wholesale, retail, selected services, financial, and tourist employment exhibited similar relationships to highways (table 14). Particular types of tertiary employment did not vary much in their relationships to highways. The access network was more correlated with sector employment than were its basic road types. High substitutability was apparent among multilane, Federal, and State highways. Local roads in 1954 were usually more highly correlated with 1960 employment than was the feeder network as a whole. Local roads were also the most important road type in 1954. Consequently, it was inferred that local roads, and State highways integrated with existing Federal routes, were the most influential highway types for the location of trades and services.

IMPLICATIONS FOR REGIONAL GROWTH THEORIES

Location theory has been proposed as a framework for analyzing highway impacts (11). Location theory is basically used in determining firms' optimum spatial locations. The optimum location is that areal point where maximum profits are obtained. Many production, marketing, transportation, and intangible factors influence location decisions (13). The major economic factors include input prices, transportation costs, location of inputs and markets, production functions, and demand (3, pp. 18-19; 27; 29; pp. 33-125). Highway investments influence firms' optimum locations insofar as they affect transportation costs and time. The formation of an industrial export base, however, depends on the totality of a region's comparative advantages.

As stated earlier, location theory postulates that more and better highways in an area should attract new manufacturing firms and foster concentrated tertiary business expansion therein. Empirical results obtained in the present study for manufacturing employment indicated that only the printing and machinery sectors were moderately dependent on specific highway types. Other manufacturing sectors exhibited less association with highway types than did the two sectors mentioned above. On the other hand, tertiary services of all types were more highly associated with highways than were manufacturing sectors. For both manufacturing and tertiary services, the primary roads affecting location would be State highways integrated with existing Federal routes and local roads integrated with urban centers. Consequently, it was concluded that nonhighway factors would be at least as important as highways in determining industrial location. Location theory has probably overemphasized the role of transportation costs.

Aggregate growth models as developed by Siebert (32) offer a comprehensive theory of regional economic growth. This aggregate theory synthesizes internal and external forces, as well as supply and demand considerations (32, pp. 24-153). Attainable regional income from internal sources is defined by Siebert as the lesser of potential regional production or actual regional demand. Determinants of internal regional output include capital, labor, land, technical knowledge, and transport resources available within the region. Expansion effects from external sources are caused by interregional input (factors of production) movements and commodity movements. The former lead to increased regional production possibilities. The latter lead to specialization of production with more efficient input usage and realization of comparative advantages. Transport resources represent a derived demand for intraregional and interregional mobility of inputs and commodities at lower transport costs.

Aggregate growth models postulate that more and better highways should encourage higher regional incomes by increasing potential aggregate regional production, factor mobility, and commodity movements provided demand is not limiting growth and terms of trade are favorable. This theory, however, maintains that highways constitute only one of many factors necessary for regional growth. Empirical results obtained in the present study for highway and income relationships concurred with this theory. Highways did contribute somewhat to the explanation of income variations. State highways, interconnecting with existing Federal routes, were of primary importance. Local roads, offering rural access to urban centers, were of secondary importance.

Both location theory and aggregate growth models indicate that highways function only as permissive causes of regional development insofar as they primarily affect potential regional supply conditions. Several alternative roles for highways are possible. In a few cases, highways might possibly impede local growth by stimulating outmigration of people and importation of competing products. On the other hand, they can occasionally constitute the major cause of growth. But in general, highways are judged to be necessary, although not sufficient, conditions for economic development. The permissive character of highway investments is repeatedly stressed (34, 40).

Table 1.--Mileage of Ozarks Region's roads, by State, 1954, 1959, and 1963

Year and area	Mileage					
	Multilane	Federal	State	Local	Unpaved	Total
1954:						
Arkansas	6.8	1,463.2	2,062.1	463.2	34,621.1	38,616.4
Missouri	121.0	1,435.7	2,483.8	1,171.4	31,100.1	36,312.0
Oklahoma	75.6	1,692.0	1,975.7	413.5	30,619.6	34,776.4
Region	203.4	4,590.9	6,521.6	2,048.1	96,340.8	109,704.8
1959:						
Arkansas	31.0	1,472.8	3,364.0	955.7	32,244.2	38,067.7
Missouri	209.7	1,380.0	3,177.6	3,943.8	28,200.0	36,911.1
Oklahoma	234.6	1,725.9	2,819.1	1,195.2	30,735.3	36,710.1
Region	475.3	4,578.7	9,360.7	6,094.7	91,179.5	111,688.9
1963:						
Arkansas	97.6	1,473.0	3,961.2	1,222.0	32,287.0	39,040.8
Missouri	284.3	1,334.3	3,457.0	5,427.8	27,228.8	37,732.2
Oklahoma	312.6	1,754.1	3,001.0	1,998.6	30,361.3	37,427.6
Region	694.5	4,561.4	10,419.2	8,648.4	89,877.1	114,200.6

Table 2.--Mileage of Ozarks Region's roads by land area, by State, 1954, 1959, and 1963 1/

Year and area	Mileage per hundred square miles					
	Multilane	Federal	State	Local	Unpaved	Total
1954:						
Arkansas	.022	4.772	6.726	1.511	112.923	125.954
Missouri	.416	4.936	8.540	4.027	106.925	124.844
Oklahoma	.260	5.818	6.794	1.422	105.287	119.581
Region	.229	5.168	7.342	2.306	108.459	123.504
1959:						
Arkansas	.101	4.804	10.972	3.117	105.170	124.164
Missouri	.721	4.745	10.925	13.559	96.954	126.904
Oklahoma	.807	5.934	9.694	4.110	105.685	126.230
Region	.535	5.155	10.538	6.861	102.648	125.737
1963:						
Arkansas	.318	4.804	12.920	3.986	105.310	127.338
Missouri	.977	4.587	11.885	18.661	93.615	129.725
Oklahoma	1.075	6.032	10.319	6.872	104.399	128.697
Region	.782	5.135	11.730	9.736	101.182	128.565

1/ Square miles of land area are as follows: Arkansas - 30,659, Missouri - 29,086, Oklahoma - 29,082, Region - 88,827.

Table 3.--Ranges of highway mileage observations, Ozarks Region, 1954, 1959, and 1963

Year and variable	Mileage per hundred square miles		
	Low	Mean	High
1954:			
Multilane	0.0	0.2	4.8
Federal	0.0	5.2	14.9
State	0.2	7.6	23.1
Local	0.0	2.4	27.6
Unpaved	52.8	109.8	204.2
1959:			
Multilane	0.0	0.5	7.2
Federal	0.0	5.2	14.4
State	2.1	10.8	31.0
Local	0.0	7.2	64.0
Unpaved	49.8	103.8	193.0
1963:			
Multilane	0.0	0.8	9.2
Federal	0.0	5.1	13.8
State	2.8	12.0	32.3
Local	0.0	10.1	75.1
Unpaved	41.4	102.2	183.6

Table 4.--Rank correlation coefficients between road and income types, Ozarks Region, 1954, 1959, and 1963

Year and road type	Total income per hundred square miles, 1959	Per capita income, 1959	Family median income, 1959
1954:			
Multilane	.354	.346	.317
Federal	.404	.308	.296
State	.325	.374	.312
Local	.681	.541	.565
Unpaved	.446	.214	.176
Access	.684	.660	.585
Feeder	.497	.258	.227
Total	.562	.336	.293
1959:			
Multilane	.583	.570	.565
Federal	.337	.259	.234
State	.239	.253	.243
Local	.501	.543	.523
Unpaved	.411	.170	.126
Access	.662	.611	.583
Feeder	.510	.279	.236
Total	.566	.345	.303
1963:			
Multilane	.624	.659	.612
Federal	.279	.185	.162
State	.242	.238	.223
Local	.505	.588	.566
Unpaved	.356	.096	.045
Access	.622	.555	.522
Feeder	.514	.280	.229
Total	.583	.359	.306

Table 5.--Stepwise regression results for 1959 total income per hundred square miles as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region 1/

1954 roads		1959 roads		1963 roads	
Variables 2/	Regression coefficients 3/	Variables 2/	Regression coefficients 3/	Variables 2/	Regression coefficients 3/
C·L	.00440	C^3	.00002	C^3	.00009
E^3	.00188	E^3	.00323	E·M	.14557
E^2	-.14079	E^2	-.24753	M·U	-.01918
C^3	.00002	E	5.96697	C^2	-.00651
E	3.38908	L	.27928	C	.14795
E·L	.04003	E·F	.02912	M·L	-.01887
S·U	.00047	F	-.63956	C·L	.00182
M·U	.00266	L·U	-.00246	C·F	.00960
F^3	.00092	U	.02469	E·S	.00867
L·U	-.00823	S·L	.00619	S^3	-.00024
L^3	-.00052			M·S	.05862
U	.01540			U^3	.000003
				C·U	-.00067
				T·M	-.08200
				E·U	-.00095
Constant	-26.96272	Constant	-46.95795	Constant	.31283
R^2	.9826	R^2	.9622	R^2	.9624
S.E.	.8271	S.E.	1.2092	S.E.	1.2341

1/ Total income in millions of dollars.

2/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

3/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 6.--Stepwise regression results for 1959 per capita income as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
E	43.802	E	21.616	E	19.853
T·S	.459	M·S	3.200	M·S	2.413
C·F	.330	C^2	.032	S·L	.269
M·S	5.586	U	-1.085	T	5.232
U	-1.442	T·S	.200	U	-2.130
E^2	-.447			C·U	.053
				C·E	-.137
Constant	272.005	Constant	524.521	Constant	557.322
R^2	.8322	R^2	.8007	R^2	.8245
S.E.	95.842	S.E.	104.008	S.E.	98.422

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 7.--Stepwise regression results for 1959 family median income as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
C·E	.588	C·E	.596	E	85.499
E	95.197	E	92.801	N·L	1.218
N·L	10.297	M·S	10.652	M	218.647
L·U	-1.162	N·L	2.841	M·L	-8.200
S^2	1.505	L·U	-.438	E^3	-.013
M·U	1.716	E^3	-.019	C·L	.813
E^3	-.019	N·C	-.469	L·U	-.220
T·U	-.108	N·S	.661	N^3	.006
S·L	-5.040				
N·C	-.276				
Constant	735.016	Constant	541.633	Constant	697.324
R^2	.8286	R^2	.8221	R^2	.8228
S.E.	315.656	S.E.	318.880	S.E.	318.189

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 8.--Rank correlation coefficients between 1954, 1959, and 1963 road types and 1960 labor force characteristics, Ozarks Region

Year and road type	Employment rate 1/	Percentage working 48-52 weeks 2/	Percentage commuting 3/
1954:			
Multilane	.099	.215	.046
Federal	-.047	.218	-.136
State	.146	.223	.078
Local	-.003	.457	.054
Unpaved	.229	.312	.005
Access	.126	.375	-.003
Feeder	.239	.355	-.006
Total	.229	.391	.002
1959:			
Multilane	.050	.353	.023
Federal	-.053	.172	-.158
State	.099	.110	.097
Local	.282	.610	.083
Unpaved	.151	.211	.023
Access	.080	.292	.037
Feeder	.213	.343	.032
Total	.213	.370	.033
1963:			
Multilane	.001	.348	.054
Federal	-.026	.126	-.172
State	.081	.074	.038
Local	.295	.603	.068
Unpaved	.116	.136	.014
Access	.097	.246	-.008
Feeder	.232	.340	.037
Total	.228	.366	.024

1/ Percentage of total civilian labor force employed.
2/ Percentage of all persons employed who worked 48-52 weeks.
3/ Percentage of total civilian labor force working outside county of residence.

Table 9.--Stepwise regression results for 1960 employment rates as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
E·U	.00068	L·U	.00051	L·U	.00053
N·C	-.00139	N·C	-.00155	N·C	-.00141
		E	.07902	E·U	.00040
Constant	92.94814	Constant	92.55724	Constant	93.30751
R^2	.1535	R^2	.1779	R^2	.1902
S.E.	1.7952	S.E.	1.7764	S.E.	1.7630

See footnotes below.

Table 10.--Stepwise regression results for 1959 employment of 48-52 weeks as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
E	1.61088	E	.55667	L·U	.00315
L	.36892	L	1.11696	E	.36824
E^2	-.02183	E·L	-.02687	M·L	-.03076
Constant	26.78476	Constant	37.12842	Constant	41.67740
R^2	.3502	R^2	.4462	R^2	.4247
S.E.	5.3114	S.E.	4.9032	S.E.	4.9975

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 11.--Stepwise regression results for 1960 commuting as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
T·E	-.00812	T·E	-.01039	T·E	-.01343
N·M	.12337	M·S	.16179	M·U	.03255
F·S	.06542			M·F	-.30665
C^3	-.00002			F·S	.03768
Constant	15.91321	Constant	18.14862	Constant	17.71887
R^2	.1958	R^2	.1804	R^2	.2421
S.E.	6.4045	S.E.	6.4122	S.E.	6.2174

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 12.--Rank correlation coefficients between 1954, 1959, and 1963 road types and 1960 manufacturing employment per hundred square miles by standard industrial classifications, Ozarks Region

Road type and year	Total manufacturing 19-39	Food 20	Apparel and textiles 22-23	Wood products 24-25	Printing 27	Chemicals 28	Metals 19, 33, 34	Machinery 35-36	Transportation 37
1954:									
Multilane	.215	.230	.160	-.112	.300	.177	.184	.304	.272
Federal	.287	.278	.239	.023	.408	.366	.317	.374	.344
State	.158	.254	.203	-.216	.249	.161	.149	.219	.155
Local	.505	.461	.337	-.088	.622	.439	.533	.611	.533
Unpaved	.294	.515	.172	-.154	.452	.251	.254	.458	.388
Access	.408	.461	.385	-.248	.578	.444	.401	.544	.434
Feeder	.347	.556	.211	-.130	.501	.296	.299	.503	.432
Total	.368	.585	.243	-.171	.551	.331	.335	.550	.460
1959:									
Multilane	.337	.341	.182	-.209	.485	.337	.380	.440	.385
Federal	.237	.239	.220	.026	.344	.311	.265	.298	.268
State	.173	.210	.189	-.090	.173	.085	.083	.142	.080
Local	.391	.290	.245	-.142	.456	.413	.425	.484	.524
Unpaved	.199	.451	.108	-.232	.389	.248	.177	.402	.321
Access	.458	.467	.399	-.161	.573	.403	.387	.507	.388
Feeder	.296	.521	.193	-.221	.484	.329	.275	.501	.430
Total	.333	.550	.231	-.223	.529	.364	.314	.542	.447
1963:									
Multilane	.247	.332	.174	-.360	.517	.259	.446	.448	.323
Federal	.206	.194	.171	.048	.281	.263	.217	.244	.237
State	.193	.239	.209	-.026	.187	.101	.101	.138	.056
Local	.372	.262	.278	-.177	.469	.343	.392	.488	.447
Unpaved	.152	.416	.091	-.223	.337	.201	.130	.352	.309
Access	.457	.502	.373	-.095	.541	.380	.379	.477	.343
Feeder	.296	.532	.195	-.228	.489	.311	.258	.515	.453
Total	.340	.568	.235	-.232	.541	.348	.306	.560	.471

Table 13.--Stepwise regression results for 1960 total manufacturing employment per hundred square miles as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 raods	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
C·L	.50232	C^3	.00652	C^3	.00713
C^3	.00529	C^2	-.57355	M·L	.50695
T·C	-.23161	C	10.80851	C^2	-.62780
C·E	.17078	C·F	.57430	C	12.50686
L^3	-.01822	T·F	-1.36793	C·F	.59740
C^2	-.44331	F·S	2.10742	C·E	.17216
C	10.00822	S^3	-.00996	T·U	-.07310
C·F	.23525	C·U	-.03664	S·U	.15890
		C·E	.16803	S^3	-.01591
		F^3	.09248	C·U	-.04571
		T·L	.13703	M·S	1.06050
Constant	68.07373	Constant	101.93530	Constant	77.64697
R^2	.9226	R^2	.9225	R^2	.9163
S.E.	71.9619	S.E.	72.9380	S.E.	75.7992

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; T = percentage of total civilian labor force in trades and services in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

Table 14.--Rank correlation coefficients between 1954, 1959, and 1963 road types and 1960 trades and services employment per hundred square miles by standard industrial classifications, Ozarks Region

Road type and year	Total trades and services 50, 52-67, 70, 72, 73, 75, 76, 78, 79	Wholesale 50	Retail 52-59	Financial 60-67	Services 70, 72, 73, 75, 76, 78, 79	Recreation-related 58, 70, 72, 78, 79
1954:						
Multilane	.354	.334	.355	.353	.318	.338
Federal	.431	.372	.427	.397	.444	.432
State	.306	.294	.313	.295	.264	.293
Local	.659	.662	.665	.593	.630	.639
Unpaved	.477	.480	.478	.496	.406	.403
Access	.673	.609	.679	.635	.639	.667
Feeder	.528	.530	.528	.547	.457	.453
Total	.590	.584	.591	.602	.519	.519
1959:						
Multilane	.569	.525	.564	.576	.552	.562
Federal	.365	.315	.361	.339	.382	.372
State	.227	.203	.228	.208	.204	.200
Local	.505	.499	.502	.465	.456	.479
Unpaved	.438	.433	.441	.442	.366	.368
Access	.657	.565	.652	.608	.651	.642
Feeder	.537	.536	.540	.538	.459	.463
Total	.590	.581	.592	.586	.516	.519
1963:						
Multilane	.591	.505	.594	.574	.590	.606
Federal	.308	.262	.304	.298	.330	.316
State	.232	.203	.230	.202	.210	.200
Local	.497	.504	.499	.459	.443	.462
Unpaved	.396	.393	.401	.393	.342	.338
Access	.618	.533	.613	.576	.607	.592
Feeder	.553	.556	.557	.550	.481	.482
Total	.617	.606	.619	.609	.549	.549

Table 15.--Stepwise regression results for 1960 total trades and services employment per hundred square miles as function of 1954, 1959, and 1963 road types and selected 1960 population characteristics, Ozarks Region

1954 roads		1959 roads		1963 roads	
Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/	Variables 1/	Regression coefficients 2/
C^3	.00636	C^3	.00651	C^3	.00680
C·L	.40269	C^2	-.53827	C^2	-.55388
C^2	-.52718	C·E	.65629	C·E	.31033
C·E	.16442	C·F	.67834	C·U	-.07832
L·U	-.71838	C·U	-.07294	C·F	.66533
E·L	4.05032	E^3	.13564	E^3	.13075
L^2	-3.04515	S·U	.13835	U^3	.00008
U	1.15303	S^3	-.01416	E^2	-10.42229
F·L	4.83270	E^2	-11.08746	E	264.98975
N·L	-1.44430	E	285.74731	F·S	1.18936
N·S	.24169	L	12.50698	F·U	-.15899
C	7.53121	L·U	-.08722	C	9.58605
				C·M	1.66320
				M·U	-.45407
				L^3	-.00482
				L^2	.38704
				N·L	-.18609
Constant	-60.19702	Constant	-2358.22217	Constant	-2119.21460
R^2	.9783	R^2	.9523	R^2	.9630
S.E.	69.7267	S.E.	103.3604	S.E.	93.0938

1/ Variables are listed by order of entrance into the regression function; C = percentage of population that was urban in 1960; E = percentage of population 25 years old or more who had completed 12 or more grades of school, 1960; N = percentage of total civilian labor force in manufacturing in 1960; M = multilane; F = Federal; S = State; L = local; U = unpaved roads.

2/ Regression coefficients, R squares, and standard errors of the estimates are those in the final step of the procedure.

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